Data Conversion Binary Code Formats

Application Note | May 1997 | AN9657.1

Introduction

Many of the Intersil DSP products have selectable data formats for their input/output interfaces. Table 1 defines the codes as used in these interfaces. Because many applications involve conversion of the analog signals, the analog scale is given as a reference. This table should clarify the interface of the DSP parts to the data conversion device.

Table 1 also helps users understand the basis for each of these formats. The following definitions are offered as the basis for each code format:

Offset Binary: A binary code in which the code represents analog values between Full Scale and -Full Scale. All zero corresponds to -Full Scale. This code can be balanced by appending a 1 below the LSB.

2's Complement: A binary code in which positive and negative codes of the same magnitude sum to all zero's plus a carry. The 2's complement can be generated from the Offset Binary code by inverting the MSB. A negative number is generated by inverting each bit of the positive number, then adding one.

Example: 011 (+3) $\longrightarrow$ 100 + 1 = 101 (-3)

1's Complement: Bipolar binary code in which positive and negative codes of the same magnitude sum to all one's. A negative number is generated by investing each bit of the positive number.

Example: 011 (+3) $\rightarrow$ 100 (-3)

Sign Magnitude: A binary code in which the MSB represents positive (1) and negative (0) polarities. The code in the table uses a offset binary code to represent the magnitude portion of the number.

TABLE 1. BINARY DATA FORMATS FOR DATA CONVERSION

SCALE	OFFSET BINARY	2'S COMPLEMENT	1'S COMPLEMENT	SIGN MAGNITUDE
+Full Scale	1111....1111	0111....1111	0111....1111	1111....1111
+0.75 Full Scale	1110....0000	0110....0000	0110....0000	1110....0000
+0.5 Full Scale	1100....0000	0100....0000	0100....0000	1100....0000
+0.25 Full Scale	1010....0000	0010....0000	0010....0000	1010....0000
+0	1000....0000	0000....0000	0000....0000	1000....0000
-0			1111....1111	0000....0000
-0.25 Full Scale	0110....0000	1110....0000	1101....1111	0010....0000
-0.5 Full Scale	0100....0000	1100....0000	1011....1111	0100....0000
-0.75 Full Scale	0010....0000	1010....0000	1001....1111	0110....0000
-Full Scale + 1 LSB	0000....0001	1000....0001	1000....0000	0111....1111
-Full Scale	0000....0000	1000....0000	----....----	----....----

As an example, let's plot a cosine wave in each of the data formats. Assume that full scale is ±1V. Table 2 details the values of the sampled sinusoid in each of the data formats. Figures 1 through 4 illustrate these signals when converted back to analog using an offset binary converter.

TABLE 2. SAMPLED COSINE SIGNAL REPRESENTATION

n	COS(nπT/16)	OFFSET BINARY	2'S COMPLEMENT	1'S COMPLEMENT	SIGN MAGNITUDE
0	1	11111	01111	01111	11111
1	0.980785	11111	01111	01111	11111
2	0.92388	11110	01110	01110	11110
3	0.83147	11100	01100	01100	11100
4	0.707107	11010	01010	01010	11010
5	0.55557	11000	01000	01000	11000
6	0.382683	10101	00101	00101	10101
7	0.19509	10010	00010	00010	10010
8	0	10000	00000	00000	10000
9	-0.19509	01100	11100	11101	00010
10	-0.38268	01001	11001	11010	00101
11	-0.55557	00110	10110	10111	01000
12	-0.70711	00100	10100	10101	01010
13	-0.83147	00010	10010	10011	01100
14	-0.92388	00001	10001	10001	01110
15	-0.98079	00000	10000	10000	01111
16	-1	00000	10000	10000	01111
17	-0.98079	00000	10000	10000	01111
18	-0.92388	00001	10001	10001	01110
19	-0.83147	00010	10010	10011	01100
20	-0.70711	00100	10100	10101	01010
21	-0.55557	00110	10110	10111	01000
22	-0.38268	01001	11001	11010	00101
23	-0.19509	01100	11100	11101	00010
24	0	10000	00000	00000	10000
25	0.19509	10010	00010	00010	10010
26	0.382683	10101	00101	00101	10101
27	0.55557	11000	01000	01000	11000
28	0.707107	11010	01010	01010	11010
29	0.83147	11100	01100	01100	11100
30	0.92388	11110	01110	01110	11110
31	0.980785	11111	01111	01111	11111
32	1	11111	01111	01111	11111

Data Conversion Binary Code Formats

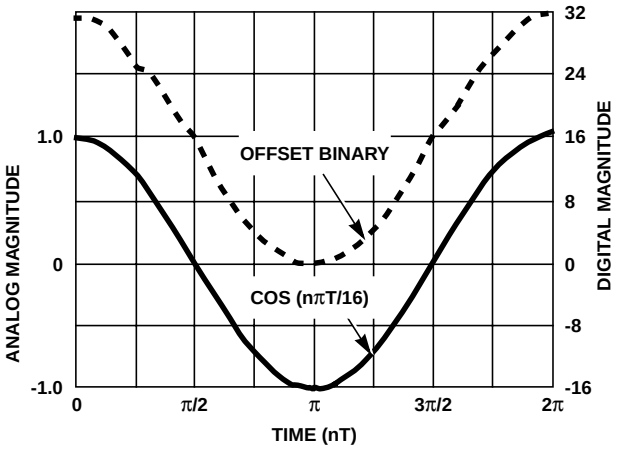

FIGURE 1. OFFSET BINARY CODE PLOTTING COS(nT) †

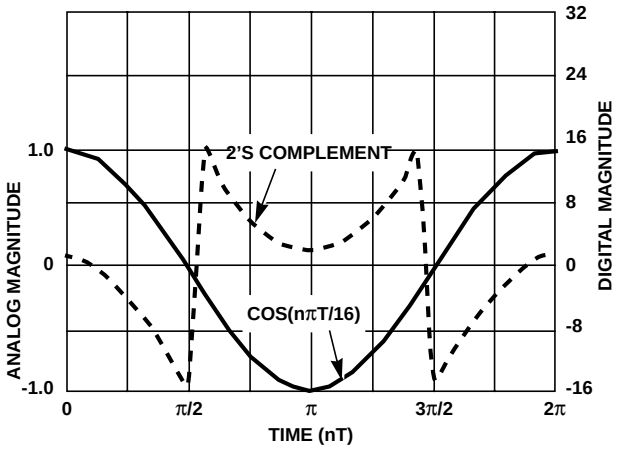

FIGURE 2. 2'S COMPLEMENT BINARY CODE PLOTTING COS(nT) †

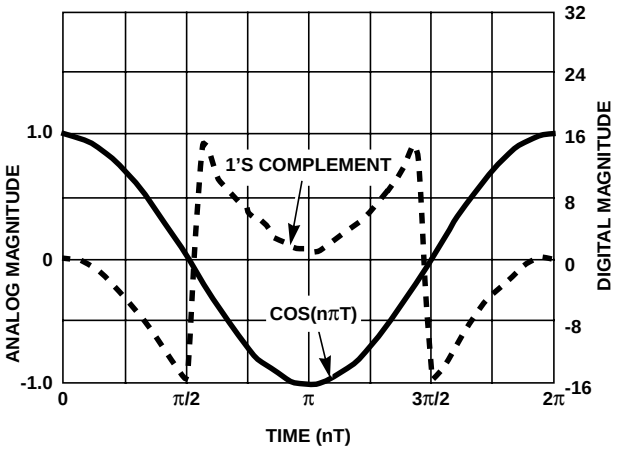

FIGURE 3. 1'S COMPLEMENT BINARY CODE PLOTTING COS(NT) †

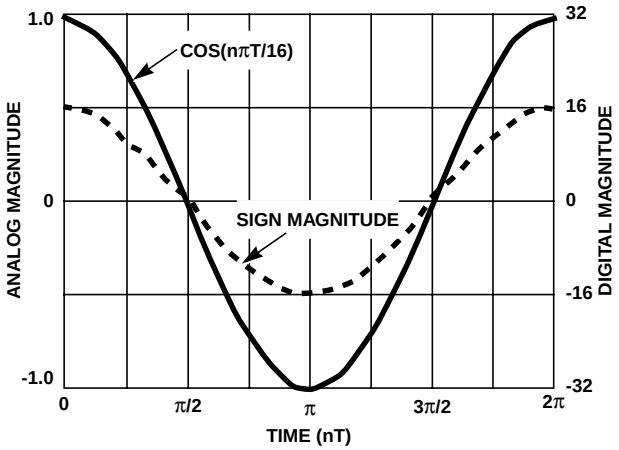

FIGURE 4. SIGN MAGNITUDE/OFFSET BINARY CODE PLOTTING COS(nT) †

† Note that the solid line denotes the regular cosine wave and the dashed line denotes the plot of the digital format code, connected to decimal.